Oxidative Stress Evaluation in Rats Anesthetized with Isoflurane or Sevoflurane

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Abstract

Oxidative stress implies an imbalance between antioxidant production and reactive oxygen species generation. In this experimental study, we aimed to assess the effects of two inhalational anesthetics (isoflurane and sevoflurane) on the antioxidant enzymes, namely: superoxid dismutase and glutathione peroxidase. Our protocol included 40 Wistar female rats, divided into 8 groups (5 animals per group): IM, I1, I2, I3, SM, S1, S2 and S3. The groups were subduced to: oxygen alone (control groups IM and SM), isoflurane (I1, I2, I3) and sevoflurane anesthesia (S1, S2, S3), 3 times, for 2 hours long, every other day. The supplied oxygen was 1l O₂/min and the concentration of isoflurane and sevoflurane was 1 minimum alveolar concentration (1 MAC). We harvested blood samples from each group at different moments: IM, SM, I1, S1 – immediately, I2, S2 – 6 hours and I3, S3 – 24 hours after the treatment. We assessed superoxid dismutase and glutathion peroxidase in the red blood cells. Both anesthetics did not significantly change the SOD activity, while GPx was significantly decreased in groups I3, S3 ($p < 0.05$) and S2 ($p < 0.01$).

Keywords: *glutation peroxidase, isoflurane, sevoflurane, superoxid dismutase.*

INTRODUCTION

The inbalance between antioxidant production and reactive oxygen species generation characterizes the oxidative stress. There is little information about lipoperoxidation, antioxidant capacity and oxidative DNA damage in isoflurane or sevoflurane anesthetized patients, during surgical procedures (Salvadori, 2012).

AIMS AND OBJECTIVES

This study aimed to evaluate the effects of isoflurane and sevoflurane anesthesia on two antioxidant enzymes (superoxid dismutase and glutathione peroxidase) on rats undergoing repeated inhalation anesthesia.

MATERIALS AND METHODS

The Scientific Research Ethics Committee of UASVM Cluj-Napoca approved the protocol of the study, which included 40 female Wistar rats. The animals were divided into 8 groups. Groups I1, I2, I3 were anesthetized with isoflurane, groups

S1, S2, S3 with sevoflurane and groups IM and SM were the control groups. The control groups were exposed to oxygen alone (1l O₂/min – 3 times for 2 hours long, every other day). The experimental groups were anesthetized 3 times, for 2 hours long, every other day. Blood samples were harvested from the retro-orbital venous sinus, in 2 ml K₃ EDTA vacutainer tubes at different times: immediately (IM, SM, I1, S1), 6 hours (I2, S2) and 24 hours (I3, S3) after the anesthetic treatment.

Superoxid dismutase (SOD) and glutathion peroxidase (GPx) activities were assessed in the erythrocytes by a kinetic method described by Flohe and Otting (1984) and Flohe and Gunzler (1984), respectively. The reactives used for SOD determination were: Xanthine oxidase gr. III 25 UN (Germany) and Cytocrome c 100 mg (Germany) and for GPx: β Nicotinamide adenine dinucleotide phosphate 25 mg (Germany), L-glutathione reduced 1 g (Germany) and Glutathione Reductase 100 U (Germany). We used a Jasco V-530 Spectrophotometer, with double beam that covers

Tab. 1. Erythrocyte concentrations of antioxidant enzymes (mean values)

Group	Isoflurane				Sevoflurane			
	IM	I1	I2	I3	SM	S1	S2	S3
SOD(U/ g Hb)	1171.36	728.57	1286.94	1117.82	1430.46	1296.08	895.42	762.75
GPx (U/ g Hb)	69.22	48.65	56.38	38.34*	109.64	72.03	46.82**	35.79*

*p<0.05 and **p<0.01 compared to the control group values

wavelengths from 200 to 900 nm. For the statistical analysis we used the GraphPad Software, where we applied the Student's t test.

RESULTS AND DISCUSSION

After isoflurane anesthesia, SOD activities in erythrocytes suffered insignificant changes in all experimental groups, in comparison to the control group. GPx activities decreased after isoflurane anesthesia in group I3 (p<0.05). After sevoflurane anesthesia, erythrocytary SOD values suffered insignificant variations in: S1, S2 and S3 groups. GPx values decreased after sevoflurane anesthesia in: S1 (unsignificant), S2 (p<0.01) and S3 (p<0.05) groups.

Turkan (2004) found that the erythrocyte SOD activities were lower after isoflurane anesthesia in the first hour and on the first day than those at preoperative values and also GPx values decreased (p<0.01). Other studies showed that SOD and catalase activities decreased, while GPx activity increased after isoflurane anesthesia, but they were assessed from kidney tissue (Durak *et al.*, 1999).

Naziroglu and Gunay (1999) said that the volatile anesthetics increase the oxidative stress by decreasing the antioxidant defense while, Durak *et al.* (1999) stated that the mechanism of oxidative stress induction takes place by generation of free radicals (e.g. superoxide anion).

CONCLUSION

Our results show that the inhalational anesthetics do not change the activity of SOD significantly. On the other hand, the GPx activity values are decreased significantly (p<0.05) 24

hours post-anesthesia after both isoflurane and sevoflurane anesthesia, and only sevoflurane decreased the GPx activity very significant (p<0.01) in group S2. Thus, the inhalational anesthetics induce oxidative stress to a certain extent, by lowering the antioxidant defense.

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